Non-Invasive Cardiovascular Alterations Monitoring in Microgravity, Phase II

Problem Statement

- Early detection of cardiovascular changes is of prime importance for assessing astronaut health in space on short and long term missions. Current technologies (echocardiography, ICG) remain complex for routine use. Therefore, a novel non-invasive ballistocardiograph (BCG) based pulse wave velocity (PWV) system PWV is proposed to monitor for cardiovascular deconditioning.
- This PWV system is suited for both terrestrial and space use. Testing in reduced gravity will provide vital information to relate future micro-gravity measurements to existing ground studies.
- Potential Users: NASA, for preventive monitoring and titration of counter-measures in space. Healthcare providers, for ground-based cardiovascular risk assessments.

Technology Development Team

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Support: Self-funded, with support from Stanford University.

Proposed Flight Experiment

Experiment Readiness:

- 09/15/2014

Test Vehicles:

- Parabolic aircraft

Test Environment:

- Experiment will require microgravity (0g) environment.

Test Apparatus Description:

- To quantify PWV, the timings of central artery pulsations are measured using a (1) microgravity-tested BCG weighing scale attached to the airframe, and an (2) ankle-worn photoplethysmograph (PPG) sensor. Test subjects are rigidly coupled to the scale using modified snowboard bindings (Fig 2). Data is streamed to a laptop for visualization, as well as logged locally.

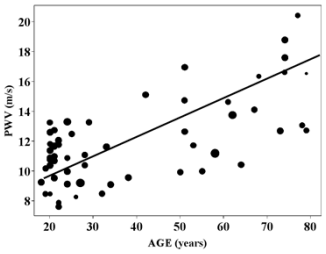

Fig 1: Ground-based PWV vs. Age TRL 4 feasibility study in fifty human test subjects (left)

Fig 2: BCG scale microgravity feasibility study (51P)

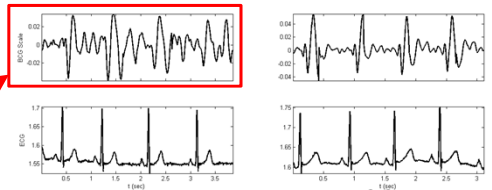

Fig 3: Microgravity scale-based BCG recordings (top-left) compared to ground-based BCG recordings (top-right). Reference ECGs (bottom)

Technology Maturation

This flight campaign is expected to lead to the following maturation steps:

- Successful recordings of scale-based PWV in microgravity.
- Successful collection of ground and microgravity PWV measurements using the same device.
- Validation of the relationship between ground-based and microgravity-based measurements.

A new device at TRL 6 could be validated in a 2014 flight campaign.

Objective of Proposed Experiment

- Demonstrate scale-based BCG recordings in microgravity.
- Refine noise-cancellation algorithms for high-quality BCG recording in microgravity.
- Gather BCG measurements in 1 and 0g using the same device, allowing interpretation of micro-gravity data in light of ground studies.
- Collect free-floating acceleration BCG data, for comparison with existing microgravity BCG data.

Applicable to TA-06 (Human Health, Life Support & Habitation Systems) - Human Health and Performance